PATENT ABSTRACTS OF JAPAN

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(54) MULTILAYER WIRING BOARD WITH BUILT-IN ELECTRONIC ELEMENT

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a multilayer wiring board with a built-in electronic element which has an excellent connection reliability and is small in size and light-weight, by eliminating the problem that a poor electric connection could occur due to thermal stress caused by a large difference in thermal expansion between the electronic element and insulation layers.

SOLUTION: The multilayer wiring board 9 with a built-in electronic element has

such a structure that a plurality of insulation layers 3 formed of an organic material are stacked, and that a wiring conductor 4 is formed on the surface of each insulation layer 3, with the wiring conductors 4 located on and under the insulation layer 3 being electrically connected via a through conductor 5 formed in the insulation layer 3. The multilayer wiring board 9 includes a built-in electronic element 8 having an extraction electrode 13 electrically connected to either the wiring conductor 4 or the through conductor 5 inside a cavity 7 formed in at least one of the insulation layers 3. At least part of the insulation layer 3 located immediately above and below the electronic element 8 is such that a coating layer 2 such that inorganic insulation powder is combined with thermosetting resin is formed on the top and the bottom face of a liquid crystal polymer layer 1, with the coating layer 2 in contact with the electronic element 8 thicker than the one 2 on the opposite side. Due to this structure, the problem that a poor electric connection could occur due to thermal stress caused by a large difference in thermal expansion between the electronic element and the insulation layers can be solved.

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CLAIMS

[Claim(s)]

[Claim 1]

A conductor is formed. while carrying out the laminating of two or more insulating layers which consist of an organic material -- the front face of these insulating layers -- wiring -- Through a conductor, connect electrically and it changes. said wiring located up and down on both sides of said insulating layer -- a conductor -- the penetration formed in said insulating layer in between -- It is the multilayer-interconnection substrate with a built-in electronic device which contained the electronic device which has the cash-drawer polar zone electrically connected with a conductor. the interior of the cavernous section which said insulating layer was further alike at least, and was prepared -- said wiring -- a conductor or said penetration -- Said insulating layer located in right above [of said electronic device] and directly under at least The multilayer-interconnection substrate with a built-in electronic device with which thickness of said enveloping layer of the side which forms the enveloping layer which combines inorganic insulation

powder with thermosetting resin, and grows into the vertical side of a liquid crystal polymer layer, and touches said electronic device is characterized by being thicker than the thickness of said enveloping layer of the opposite side.

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention]

This invention relates to the wiring substrate which contained electronic devices, such as a capacitor element used for electronic equipment, such as various AV equipments, a household-electric-appliances device, communication equipment and a computer, and its peripheral device.

[0002]

[Description of the Prior Art]

A conductor is formed. wiring of plurality [front face / which consist of organic resin ingredients, such as an insulating layer or a glass epoxy resin with which a wiring substrate consists of ceramic ingredients, such as an alumina, conventionally, / of an insulating layer / the interior and the front face] -- Through

a conductor, connect electrically and it changes. wiring located up and down -- a conductor -- the penetration which formed between in the insulating layer -- while carrying electronic devices, such as a semiconductor device, and a capacitor, a resistance element, in the front face of this wiring substrate -- these electrodes -- each wiring -- the electronic instrument used for electronic equipment is formed by connecting with a conductor.

[0003]

However, small and thin shape, and lightweight-ization is required as electronic equipment being represented by mobile communication equipment, and small and densification are increasingly required also for the wiring substrate carried in such electronic equipment in recent years.

[0004]

Since it corresponds to such a demand, the module with built-in passive circuit elements which contained passive circuit elements, such as a chip-like capacitor element, in the interior of a wiring substrate is proposed by JP,11-220262,A in order to reduce the number of the electronic devices carried in the front face of a wiring substrate and to miniaturize a wiring substrate.

[0005]

[Patent reference 1]

JP,11-220262,A

[0006]

[Problem(s) to be Solved by the Invention]

However, the module with built-in passive circuit elements shown in JP,11-220262,A Since it is manufactured by laying the passive circuit elements mounted on copper foil under the insulating substrate which consists of an epoxy resin or cyanate resin and an epoxy resin and cyanate resin have the large coefficient of thermal expansion, If the heat which an electronic device generates at the time of actuation, the temperature change of an external environment, etc. are impressed repeatedly It had the trouble that stress will concentrate on the mounting section of passive circuit elements and a circuit pattern by the

expansion or contraction of an insulating substrate which builds in passive circuit elements, a crack will occur, and poor electrical installation, such as an open circuit, will occur.

[0007]

This invention is thought out in view of the trouble of this conventional technique, and the purpose is in offering the small and lightweight multilayer-interconnection substrate excellent in connection dependability with a built-in electronic device.

[0008]

[Means for Solving the Problem]

A conductor is formed. while the multilayer-interconnection substrate with a built-in electronic device of this invention carries out the laminating of two or more insulating layers which consist of an organic material -- the front face of these insulating layers -- wiring -- Through a conductor, connect electrically and it changes. said wiring located up and down on both sides of said insulating layer -- a conductor -- the penetration formed in said insulating layer in between -- It is the multilayer-interconnection substrate with a built-in electronic device which contained the electronic device which has the cash-drawer polar zone electrically connected with a conductor. the interior of the cavernous section which said insulating layer was further alike at least, and was prepared -- said wiring -- a conductor or said penetration -- Said insulating layer located in right above [of said electronic device] and directly under at least The enveloping layer which combines inorganic insulation powder with thermosetting resin, and grows into the vertical side of a liquid crystal polymer layer is formed, and thickness of said enveloping layer of the side which touches said electronic device is characterized by being thicker than the thickness of said enveloping layer of the opposite side.

[0009]

According to the multilayer-interconnection substrate with a built-in electronic device of this invention, the insulating layer located in right above [of an electronic device] and directly under at least From it being what forms and changes, the enveloping layer which combines inorganic insulation powder with

thermosetting resin, and grows into the vertical side of a liquid crystal polymer layer Since a liquid crystal polymer layer with a small coefficient of thermal expansion can restrain an enveloping layer with a large coefficient of thermal expansion and the coefficient of thermal expansion of an insulating layer can be made to approximate with the coefficient of thermal expansion of an electronic device Since the big thermal stress which originates in the plane of composition of an insulating layer and an electronic device at the difference of both coefficient of thermal expansion does not occur even if the heat which the electronic device carried generates at the time of actuation, the temperature change of an external environment, etc. are repeatedly impressed to a wiring substrate a crack occurring in both plane of composition, or exfoliating among both -- there is nothing -- consequently, wiring -- a conductor and penetration -- it can consider as the multilayer-interconnection substrate with a built-in electronic device which poor electrical installation, such as an open circuit, did not occur in a conductor, and was excellent in connection dependability.

[0010]

moreover, the thickness of the enveloping layer of the side which touches an electronic device an insulating layer from it being thicker than the thickness of the enveloping layer of the opposite side Since there are many amounts of the thermosetting resin with which adhesion with an electronic device is presented by the side which touches an electronic device, even if the heat which adhesion with an electronic device becomes good and the electronic device carried generates at the time of actuation, the temperature change of an external environment, etc. are repeatedly impressed to a wiring substrate between these -- exfoliation -- generating -- wiring -- a conductor and penetration -- it can consider as the multilayer-interconnection substrate with a built-in electronic device which a conductor was not disconnected and was excellent in electrical installation dependability.

[0011]

[Embodiment of the Invention]

Next, the multilayer-interconnection substrate with a built-in electronic device of this invention is explained to a detail based on an attached drawing.

[0012]

Drawing 1 is the sectional view showing an example of the gestalt of operation of a multilayer-interconnection substrate with a built-in electronic device of this invention, and drawing 2 is the expanded sectional view of the electronic device built in the multilayer-interconnection substrate with a built-in electronic device shown in drawing 1 . Moreover, drawing 3 is the partial expanded sectional view of the insulating layer 3 shown in drawing 1 .

[0013]

in these drawings, 1 is a liquid crystal polymer layer, 2 is an enveloping layer, and an insulating layer 3 mainly forms by these -- having -- **** -- 4 [moreover,] -- wiring -- a conductor and 5 -- penetration -- a conductor and 8 -- the capacitor element as an electronic device -- it is -- mainly -- an insulating layer 3 and wiring -- a conductor 4 and penetration -- the multilayer-interconnection substrate 9 with a built-in electronic device of this example consists of a conductor 5 and a capacitor element 8.

[0014]

In addition, by this example, while carrying out the four-layer laminating of the insulating layer 3 and changing, the multilayer-interconnection substrate with a built-in capacitor element which lays one capacitor element 8 underground and changes is explained.

[0015]

First, the capacitor element 8 as an electronic device built in the multilayer-interconnection substrate 9 with a built-in electronic device is explained.

[0016]

Length, width, and height are the rectangular parallelepipeds which are 1-5mm, respectively, and the capacitor element 8 is formed by preparing so that the cash-drawer polar zone 13 which connects electrode layer 11 predetermined comrades electrically may be penetrated up and down while carrying out two or

more layer laminating of the electrode layer 11 and the ceramic dielectric layer 12 to drawing 2 by turns, as shown in a sectional view.

[0017]

As an ingredient of such a ceramic dielectric layer 12, various dielectric ceramic ingredients can be used, for example, it is calcium about Ba which is the ceramic constituent of BaTiO3, or a LaTiO3, CaTiO3 and SrTiO3 grade, or the configuration element of BaTiO3, and barium titanate system ingredients, such as the solid solution which permuted Ti partially by Zr or Sn, a lead system perovskite type structure compound, etc. are mentioned.

[0018]

Moreover, as an ingredient which forms the electrode layer 11, metals and those alloys, such as Pd and Ag-Pt-nickel-Cu-Pb, are used, for example.

[0019]

furthermore, a capacitor element 8 penetrates the layered product of the electrode layer 11 and the ceramic dielectric layer 12 for two or more cash-drawer polar zone 13 electrically connected to many electrode layers 11 -- as -- having -- **** -- these -- wiring of the electrode layer 11 of a capacitor element 8, and the multilayer-interconnection substrate 9 with a built-in electronic device -- a conductor 4 and penetration -- the operation which connects a conductor 5 electrically is accomplished. In addition, although it pulled out, and the polar zone 13 was formed in this example so that the layered product of the electrode layer 11 and the ceramic dielectric layer 12 might be penetrated, the cash-drawer polar zone 13 may be formed by printing soldering paste to the end face of the layered product of the electrode layer 11 and the ceramic dielectric layer 12. However, as for the cash-drawer polar zone 13, from a viewpoint of the ease and inductance reduction of detailed-izing and a process, it is desirable to be formed so that the layered product of the electrode layer 11 and the ceramic dielectric layer 12 may be penetrated.

[0020]

Moreover, it is desirable to contain the thing of the same quality of the material as

the electrode layer 11 from a viewpoint of metals and those alloys, such as Pd and Ag-Pt-nickel-Cu-Pb, being used, and making good especially electrical installation with the electrode layer 11 as a conductor which forms the cash-drawer polar zone 13. In addition, what is necessary is for the path of the cash-drawer polar zone 13 to be several 10 micrometers - several mm, and just to decide it suitably in accordance with the magnitude of a capacitor element 8.

[0021]

Such a capacitor element 8 first For example, the metal paste for electrode layer 11 created by the well-known paste creating method in the front face of two or more BaTiO3 dielectric ceramic green sheets for the ceramic dielectric layers 12 manufactured by the well-known sheet forming method is printed so that it may become a predetermined configuration with screen printing. Then, while carrying out the laminating of these ceramic green sheets to predetermined sequence, are stuck by pressure, and a layered product is obtained. Next, while laser beam machining by punching processing, UV-YAG laser, excimer laser, carbon dioxide gas laser, etc. draws out to this layered product and punching the through tube for polar-zone 13 formation, pull out in that through tube and it is filled up with the metal paste for polar-zone 13. While cutting the layered product in predetermined magnitude finally, it is manufactured by calcinating at the temperature of 800-1600 degrees C.

[0022]

In addition, in order to consider as a detailed through tube especially, it is desirable to form a through tube by drilling processing by laser. Moreover, in order to make good electrical installation of the conductor and the electrode layer 11 with which the interior is filled up, as for a through tube, it is desirable to perform ultrasonic-cleaning processing, DESUMIA processing, etc. after punching processing or laser drilling processing.

[0023]

Moreover, the metal paste for cash-drawer polar-zone 13 is formed by distributing metal powder into the organic vehicle made to dissolve organic

binder resin in an organic solvent. In addition, in the vehicle, various dispersants, activators, plasticizers, etc. besides these may be added if needed. The organic binder resin used for this conductive paste has the role which gives proper viscosity and a proper rheology in the embedding to a through tube while making homogeneity distribute metal powder, for example, acrylic resin, phenol resin, an alkyd resin, rosin ester ethyl cellulose methyl cellulose polyvinyl alcohol polyvinyl butyrate, etc. are mentioned. It is desirable to use acrylic resin from a viewpoint of improving dispersibility of metal powder especially.

[0024]

Furthermore, as for the organic solvent used for this conductive paste, it is desirable to dissolve organic binder resin, to distribute a metal powder particle, and for an ester system, naphtha, etc., such as alcoholic systems, such as nothing, for example, alpha-terpineol, and benzyl alcohol, and a hydrocarbon system, an ether system, butyl carbitol acetate, to be used in the role which makes such whole mixed stock the shape of a paste, and to use alcohols solvents, such as alpha-terpineol, from a viewpoint of improving dispersibility of metal powder especially.

[0025]

This conductive paste can be considered as the paste which added the glass frit and the ceramic frit further again, in order to raise the bond strength to the capacitor porcelain after embedding and baking. It is not limited especially as the glass frit or ceramic frit in this case, and titanium system oxides, such as glass of a hoe silicic acid system or a hoe silicic acid zinc system and titania barium titanate, etc. can be used suitably.

[0026]

In addition, as for the front face of a capacitor element 8, it is desirable for it to be larger than 0.2 micrometers and to set 0.5 micrometers or more of maximums Rmax of arithmetic mean granularity R of the front face of the ceramic dielectric layer 12 to 1.0 micrometers or more the optimal desirably from a viewpoint of raising an adhesive property with an insulating layer 3. In addition, since the

inclination a crack and a chip become easy to generate is in a capacitor element 8 when the maximum Rmax of surface roughness R of the ceramic dielectric layer 12 exceeds 5 micrometers, what maximum Rmax of surface roughness R is set to 5 micrometers or less for is desirable.

[0027]

The front face of such a ceramic dielectric layer 12 of capacitor element 8 front face is the phase of the green sheet layered product before baking, and after giving irregularity physically by pushing roughening processing according the front face of a layered product to brushing, and the plate which carried out concavo-convex processing beforehand etc., or after it performs dimple processing by opening a non-through tube in a green sheet layered product front face with laser, it can be made into desired surface roughness by calcinating. Moreover, it is good also as desired surface roughness by the thermal resistance at the time of baking being higher than the ceramic ingredient used for the ceramic dielectric layer 12, mean particle diameter having some ceramic ingredients and reactivity which are used for ceramic powder or the ceramic dielectric layer 12 10 micrometers or more, and a pitch diameter making it adhere to a green sheet layered product front face so that a part may embed ceramic powder 10 micrometers or more, and calcinating. Furthermore, the front face of the capacitor element 8 after baking of a green sheet layered product may be roughened by the chemical technique, such as physical means, such as sandblasting, or etching.

[0028]

Next, the multilayer-interconnection substrate 9 with a built-in electronic device of this invention is explained to a detail based on drawing 1 and drawing 3 .

[0029]

wiring which changes from copper foil to the front face of these insulating layers 3 while the multilayer-interconnection substrate 9 with a built-in electronic device of this invention carries out the laminating of two or more insulating layers 3 to drawing 1 , as shown in a sectional view -- the conductor 4 is formed. moreover,

wiring located up and down on both sides of an insulating layer 3 -- the penetration which consists between conductors 4 of the conductive resin formed in the insulating layer 3 -- wiring which connects electrically through a conductor 5, changes and is located in the up-and-down outermost layer -- it considers as the connection pad 6 by which some conductors 4 are connected with an external electrical circuit. furthermore -- while building the above-mentioned capacitor element 8 in the interior of the cavernous section 7 which the insulating layer 3 was further alike at least, and was prepared -- vertical both the principal planes of the capacitor element 8 -- setting -- pulling out -- the polar zone 10 -- penetration -- a conductor 5 -- minding -- wiring -- it connects with the connection pad 6 which consists of a conductor 4 or its part electrically.

[0030]

And in the multilayer-interconnection substrate 9 with a built-in electronic device of this invention, the insulating layer 3 located in right above [of a capacitor element 8] and directly under at least has the composition in which the enveloping layer 2 which combines inorganic insulation powder with thermosetting resin, and grows into the vertical side of the liquid crystal polymer layer 1 was formed, as shown to drawing 3 in a sectional view. in addition, this example -- setting -- the insulating layer 3 of four layers -- the example at the time of considering as the configuration in which the enveloping layer 2 from which all combine inorganic insulation powder with thermosetting resin, and change to the vertical side of the liquid crystal polymer layer 1 was formed is shown.

[0031]

In addition, a liquid crystal polymer points out the polymer which has a liquid crystal condition or the property which carries out a birefringence optically here at the time of melting. The thermotropic liquid crystal polymer which shows liquid crystallinity at the time of the lyotropic liquid crystal polymer which generally shows liquid crystallinity in the state of a solution, or melting, or as a liquid crystal polymer used for this invention, including the liquid crystal polymers of all 1 mold,

2 molds, and 3 molds classified according to heat deflection temperature From a viewpoint of temperature cycle dependability, solder thermal resistance, and workability, the temperature of 200-400 degrees C and the thing which has the melting point in temperature of 250-350 degrees C especially are desirable. Moreover, the polyphenylene ether system organic substance means polyphenylene ether resin, the resin which various functional groups combined with polyphenylene ether, or these derivatives and polymers.

[0032]

Such a liquid crystal polymer layer 1 within limits which have the function in which the coefficient of thermal expansion of an insulating layer 3 is made to approximate to the coefficient of thermal expansion of a capacitor element 8 while giving mechanical reinforcement to an insulating layer 3, and do not spoil the physical properties as a layer Light stabilizer, such as an ultraviolet ray absorbent for improving the antioxidant and lightfastness for improving thermal stability, Fire-resistant assistants, such as a fire-resistant agent of the halogen system for adding fire retardancy, or a phosphoric-acid system, an antimony system compound, and boric-acid zinc, metaboric acid barium, a zirconium dioxide, In order to adjust lubricant, such as a higher fatty acid for improving lubricity, and higher-fatty-acid ester, a higher-fatty-acid metal salt, a fluorocarbon system surfactant, and a coefficient of thermal expansion, And/or, a mechanical strength The aluminum oxide, the oxidization silicon, the titanium oxide, the barium oxide, the strontium oxide, the zirconium dioxide, the calcium oxide zeolite, the silicon nitride, the alumimium nitride, silicon carbide, and titanic acid for improving Fillers, such as potassium barium titanate strontium titanate titanic-acid calcium boric-acid aluminum stannic-acid barium zirconic acid barium zirconic acid strontium, may be contained.

[0033]

In addition, the particle shape of the above-mentioned filler etc. has the shape of spherical, needlelike, and a flake etc., and is desirable from a viewpoint of restoration nature. [of the shape of a ball] Moreover, particle diameter is usually

about 0.1-15 micrometers, and is smaller than the thickness of the liquid crystal polymer layer 1.

[0034]

moreover, wiring which an enveloping layer 2 mentions later -- while having the function of the adhesives at the time of carrying out covering formation of the conductor 4, when a capacitor element 8 is built in the cavernous section 7, the duty of the adhesives at the time of carrying out the laminating of a role of adhesives and insulating-layer 3 comrades which make a capacitor element 8 fix to the cavernous section 7 interior is achieved.

[0035]

an enveloping layer 2 -- for example, the polyphenylene ether system organic substance, such as polyphenylene ether resin, and the derivative or these polymer alloys, -- 30 - 90 volume % content -- carrying out -- **** -- especially -- heat cycle dependability and wiring -- it is desirable to contain thermosetting polyphenylene ether, such as allyl compound denaturation polyphenylene ether, from a viewpoint of the location precision at the time of pasting up a conductor 4.

[0036]

In addition, if there is an inclination for kneading nature with the inorganic insulation powder later mentioned as the content of thermosetting resin, such as the polyphenylene ether system organic substance, is under 30 volume % to fall and 90 volume % is exceeded, in case an enveloping layer 2 will be formed in liquid crystal polymer layer 1 front face, there is an inclination for the thickness variation of an enveloping layer 2 to become large. Therefore, the content of thermosetting resin, such as the polyphenylene ether system organic substance, has the desirable range of 30 - 90 volume %.

[0037]

moreover, the enveloping layer 2 -- adhesion with the liquid crystal polymer layer 1, and wiring -- a conductor 4 and the penetration mentioned later -- it is desirable to contain additives, such as a polyfunctional monomer which has two or more functional groups in which a polymerization reaction is possible from a

viewpoint of making adhesion with a conductor 5 good, or a polyfunctional polymer, for example, it is desirable to contain triallyl isocyanurate, triaryl SHIANU rates, these polymers, etc.

[0038]

Furthermore, the inorganic insulation powder whose particle size of the aluminum oxide for an enveloping layer 2 adjusting the coefficient of thermal expansion, or improving a mechanical strength, oxidization silicon, titanium oxide, barium-oxide, strontium-oxide, zirconium dioxide, calcium oxide zeolite, silicon nitride, alumimium nitride, silicon carbide, and potassium titanate barium titanate strontium titanate titanic-acid calcium boric-acid aluminum stannic-acid barium zirconic acid barium zirconic acid strontium, etc. is 0.1-2 micrometers contains 10 - 70 volume %.

[0039]

The particle size such inorganic insulation powder in addition, in less than 0.1 micrometers If it is in the inclination to reduce the insulating dependability after it becomes a condensation grain with inorganic powder and that condensation grain part serves as an enveloping layer 2 in the kneading process at the time of pasting this inorganic powder and exceeds 2 micrometers wiring which the surface smoothness of enveloping layer 2 front face falls, and is made to put -- an adhesive property with a conductor 4 -- falling -- as a result -- wiring -- it is in the inclination for a location gap of a conductor 4 to become large. Therefore, the particle size of the inorganic insulation powder contained in the enveloping layer 2 has the desirable range of 0.1-2 micrometers. moreover, the time of doing the laminating and pressurization especially of the insulating layer 3, and forming the multilayer-interconnection substrate 9 with a built-in electronic device -- the fluidity of an enveloping layer 2 -- controlling -- penetration -- as for an enveloping layer 2, from a viewpoint of preventing thickness dispersion of a location gap of a conductor 5 or an enveloping layer 2, it is desirable to contain the inorganic insulation powder more than 10 volume %. furthermore, an adhesion interface with the liquid crystal polymer layer 1 and wiring -- it is desirable to make the

content of inorganic insulation powder below into 70 volume % from a viewpoint of preventing the exfoliation at the time of a solder reflow in an adhesion interface with a conductor 4.

[0040]

In addition, the configuration of inorganic insulation powder has the shape of spherical, needlelike, and a flake etc., and is desirable from a viewpoint of restoration nature. [of the shape of a ball] Moreover, the antioxidant for improving a rubber component and thermal stability for an enveloping layer 2 adjusting an elastic modulus, The halogen system for adding light stabilizer, such as an ultraviolet ray absorbent for improving lightfastness, and fire retardancy, or the fire-resistant agent of a phosphoric-acid system, Fire-resistant assistants, such as an antimony system compound, and boric-acid zinc, metaboric acid barium, a zirconium dioxide, Lubricant, such as the higher fatty acid and higher-fatty-acid ester for improving lubricity, and a higher-fatty-acid metal salt, a fluorocarbon system surfactant, Or coupling agents, such as a silane system coupling agent for raising compatibility with inorganic insulation powder and raising a mechanical strength these junction disposition top and a titanate system coupling agent, may be contained.

[0041]

Such an insulating layer 3 to for example, inorganic insulation powder, such as oxidation silicon whose particle size is 0.1-2 micrometers The paste for enveloping layer 2 which added and obtained thermosetting polyphenylene ether resin, a solvent, a plasticizer, a dispersant, etc. A contact angle with triallyl isocyanurate is 3-50 degrees by plasma treatment. And after adopting and applying the sheet casting methods, such as a well-known doctor blade method, to the vertical front face of the liquid crystal polymer layer 1 which carried out surface preparation conventionally so that surface energy may serve as 45 - 70 mJ/m2, Or after applying the above-mentioned paste layer to the front face of the liquid crystal polymer layer 1 by immersing the liquid crystal polymer layer 1 during the above-mentioned paste, and pulling up perpendicularly, It is formed by

manufacturing the precursor sheet which serves as an insulating layer 3 by heating this to the temperature in which thermosetting resin does not carry out full hardening, and carrying out warm air desiccation, carrying out the laminating of two or more sheets up and down, while performing suitable punching processing for them, and carrying out heat curing of it.

[0042]

In addition, a paste is a fluid which has suitably the predetermined viscosity which comes to add solvents, such as toluene and butyl acetate, and methyl-ethyl-ketone methanol methyl-cellosolve acetate isopropyl alcohol methyl-isobutyl-ketone dimethylformamide, to the composite material of thermosetting polyphenylene ether resin and inorganic insulation powder, and although the viscosity is based also on a sheet forming method, the range which is 100-3000poise is desirable [viscosity].

[0043]

moreover, wiring formed in the front face of an insulating layer 3 -- wiring which a conductor 4 consists of one sort or two sorts or more of alloys chosen from copper, gold, silver, aluminum, etc., and is located up and down on both sides of an insulating layer 3 -- a conductor -- four comrades -- penetration -- three-dimensional high density wiring is possible by connecting electrically through a conductor 5.

[0044]

in addition -- this example -- wiring -- formation of a conductor 4 -- a replica method -- carrying out -- **** -- such wiring -- a conductor 4 is formed by the approach described below. first, the etching-resist removal after forming a resist layer so that it may be manufactured by the front face of a mold-release sheet by the galvanizing method etc., an electrolysis metallic foil with a thickness of 1-35 micrometers it is thin from one sort or two sorts or more of alloys chosen from copper, gold, silver, aluminum, etc. may be pasted up and it may become the mirror image pattern of a desired circuit pattern on the front face -- wiring of the mirror image of a circuit pattern predetermined to a mold-release sheet top -- the

imprint sheet with which conductor 4 be formed prepares. next, a front face -- wiring -- removing a mold release sheet, after a pressure carries out pressurization heating of the imprint sheet with which the conductor 4 was formed superposition and after an appropriate time on the conditions 0.5 - 10MPa and whose temperature are 60-150 degrees C to the front face and/or rear face of a precursor sheet for insulating-layer 3 -- wiring -- a conductor 4 is imprinted on a precursor sheet. And the front face of an insulating layer 3 is covered by heating and pressurization at the time of carrying out heat curing of the precursor sheet behind two or more sheet laminating. in addition, wiring located in the up-and-down outermost layer -- let some conductors 4 be the connection pads 6 connected with an external electrical circuit.

[0045]

It functions as a conductor. moreover, penetration -- wiring with which a conductor 5 is located up and down on both sides of an insulating layer 3 -- a conductor -- four comrades and wiring -- the connection for connecting electrically a conductor 4 and the cash-drawer polar zone 13 of a capacitor element 8 -- the precursor sheet for insulating-layer 3 -- penetration -- a conductor, while laser beam machining punches the through tube for 5 formation In the through tube Metal powder, such as copper, silver, gold, and solder Into organic resin ingredients, such as an epoxy resin, and bismaleimide triazine resin, thermosetting polyphenylene ether resin, liquid crystal polymer resin, toluene and butyl-acetate methyl-ethyl-ketone methanol methyl-cellosolve acetate isopropanal PIRUARU the penetration which carries out addition mixing of the solvents, such as call methyl-isobutyl-ketone dimethylformamide, and changes -- conventionally, well-known screen printing etc. is adopted, and it is filled up with the conductive paste for conductors 5, and is formed by carrying out heat curing of it with a precursor sheet.

[0046]

furthermore, the capacitor element 8 which the cavernous section 7 is formed in a part of insulating layer 3, and was mentioned above inside this cavernous

section 7 -- that cash-drawer polar zone 13 and wiring -- the penetration which the conductor 4 prepared in right above and the insulating layer [directly under] 3 of the cavernous section 7 -- it connects electrically through a conductor 5, and is made and contained.

[0047]

Such the cavernous section 7 is formed by forming the through hole in some precursor sheets for insulating-layer 3 by laser beam machining. And while inserting a capacitor element 8 into such a through hole A laminating is carried out up and down. the location corresponding to the cash-drawer polar zone 13 of a capacitor element 8 -- penetration -- the precursor sheet for other insulating-layer 3 with which it filled up with the conductive paste for conductors 5 -- the -- Temperature 150-300 degrees C, While a capacitor element 8 is contained in the cavernous section 7 by a pressure's carrying out a hotpress on condition that 0.5-10MPa for 30 minute - 24 hours, and carrying out heat curing of a precursor sheet and the conductive paste the penetration prepared in the cash-drawer polar zone 13 and the insulating layer 3 of the upper and lower sides of a capacitor element 8 -- a conductor 5 is connected electrically.

[0048]

in addition, the case where the die length length and beside the cavernous section 7 sets length of a capacitor element 8, or the horizontal die length to Lmum -- L+3 to L+30 micrometers -- it is -- penetration -- from a viewpoint of the location precision in connection between a conductor 5 and a capacitor element 8, L+30 micrometers or less are desirable, and in case a capacitor element 8 is inserted in the cavernous section 7, from a viewpoint of making a capacitor element 8 easy to insert, L+3 micrometers or more are desirable.

[0049]

furthermore, the adhesive strength which the adhesion area of the enveloping layer 2 which has the effectiveness of the adhesives of the capacitor element 8 and the insulating layer 3 contained in the cavernous section 7 in the insulating layer 3 in which the cavernous section 7 is formed as the sum total of the

thickness of an enveloping layer 2 is below the thickness of the liquid-crystal polymer layer 1 becomes small, and fixes a capacitor element 8 -- small -- becoming -- a heat cycle test -- a capacitor element 8 and wiring -- when a load joins a connection with a conductor 4, there is an inclination which becomes easy to disconnect. Therefore, as for the sum total of the thickness of the enveloping layer 2 in the insulating layer 3 in which the cavernous section 7 is formed, it is desirable that it is larger than the thickness of the liquid crystal polymer layer 1. In addition, as for the sum total of the thickness of an enveloping layer 2, from a viewpoint of preventing the fall of the alignment precision by the resin streak at the time of carrying out the laminating of the insulating layer 3, it is desirable that they are 1.4 or less times of the thickness of the liquid crystal polymer layer 1.

[0050]

And the thickness of the enveloping layer 2 of the side which touches a capacitor element 8 is formed more thickly than the thickness of the enveloping layer 2 of the opposite side, and that is important for it while the insulating layer 3 in which the cavernous section 7 by which the capacitor element 8 was contained is located up and down in the multilayer-interconnection substrate 9 with a built-in electronic device of this invention forms the enveloping layer 2 which combines inorganic insulation powder with thermosetting resin, and grows into the vertical side of the liquid crystal polymer layer 1 and changes.

[0051]

According to the multilayer-interconnection substrate 9 with a built-in electronic device of this invention, the insulating layer 3 located in right above [of a capacitor element 8], and directly under at least From forming and changing, the enveloping layer 2 which combines inorganic insulation powder with thermosetting resin, and grows into the vertical side of the liquid crystal polymer layer 1 Since the liquid crystal polymer layer 1 with a small coefficient of thermal expansion can restrain the enveloping layer 2 with a large coefficient of thermal expansion and the coefficient of thermal expansion of an insulating layer 3 can be made to approximate with the coefficient of thermal expansion of a capacitor

element 8 Since the big thermal stress resulting from the difference of the coefficient of thermal expansion of an insulating layer 3 and a capacitor element 8 does not occur even if the heat which the electronic device carried generates at the time of actuation, the temperature change of an external environment, etc. are repeatedly impressed to a wiring substrate a crack occurring in both interface or exfoliating among both -- 7 -- it is -- **

[0052]

Moreover, the thickness of the enveloping layer 2 of the side which touches a capacitor element 8 in the insulating layer 3 in which a capacitor element 8 is located up and down is thicker than the thickness of the enveloping layer 2 of the opposite side. Since there are many amounts of the thermosetting resin with which adhesion with a capacitor element 8 is presented by the side which touches a capacitor element 8 Even if the heat which an adhesive property with a capacitor element 8 becomes good, and the electronic device carried generates at the time of actuation, the temperature change of an external environment, etc. are repeatedly impressed to a wiring substrate between these -- exfoliating -- wiring -- a conductor 4 and penetration -- it can consider as the multilayer-interconnection substrate 9 with a built-in electronic device which a conductor 5 was not disconnected and was excellent in electrical installation dependability.

[0053]

In addition, it sets to the insulating layer 3 located in right above [of a capacitor element 8], and directly under. If the thickness of the enveloping layer 2 of the side which touches a capacitor element 8 is less than 1.2 times of the thickness of the enveloping layer 2 of the opposite side In the heating process at the time of making the multilayer-interconnection substrate 9 with a built-in electronic device of this invention, if the danger that the adhesive strength of a capacitor element 8 and an insulating layer 3 will decline becomes large and exceeds another side and 3 times The differential shrinkage of an enveloping layer 2 becomes large by the upper and lower sides of the liquid crystal polymer layer 1, and the multilayer-interconnection substrate 9 with a built-in electronic device of

this invention becomes destroyed [tend] by the stress by the differential shrinkage. Therefore, in the insulating layer 3 located in right above [of a capacitor element 8], and directly under, the 1.2 to 3 times as much range of the thickness of the enveloping layer 2 of the side which touches a capacitor element 8 as the thickness of the enveloping layer 2 of the opposite side is desirable.

[0054]

According to the multilayer-interconnection substrate 9 with a built-in electronic device of this invention, in this way wiring located in the outermost layer of the multilayer-interconnection substrate 9 with a built-in electronic device of the above-mentioned configuration -- the connection pad 6 which consists of some conductors 4 -- conductors, such as solder, -- by connecting electronic parts (not shown), such as a semiconductor device, electrically through a bump (not shown) the electronic device 8 to build in and penetration -- a conductor 5 and wiring -- it can consider as the hybrid integrated circuit excellent in connection dependability with a conductor 4.

[0055]

In addition, although the multilayer-interconnection substrate 9 with a built-in electronic device of this invention manufactured the multilayer-interconnection substrate 9 with a built-in electronic device by carrying out the laminating of the insulating layer 3 of four layers in the above-mentioned example possible as for various modification when it was range which is not limited to an above-mentioned example and does not deviate from the summary of this invention, it may carry out the laminating of the insulating layer 3 of three layers or five layers or more, and may manufacture the multilayer-interconnection substrate 9 with a built-in electron. Moreover, although the insulating layer 3 in which the through hole used as the cavernous section 7 for laying an electronic device 8 underground was formed was made into one layer, it is good also as more than two-layer. Furthermore, in this example, although the case where an electronic device was a capacitor element 8 was explained, electronic devices may be other electronic devices, such as a resistor and a coil.

[0056]

[Effect of the Invention]

According to the multilayer-interconnection substrate with a built-in electronic device of this invention, the insulating layer located in right above [of an electronic device] and directly under at least From having the enveloping layer which contains thermosetting resin and inorganic insulation powder in the vertical side of a liquid crystal polymer layer Since a liquid crystal polymer layer with a small coefficient of thermal expansion can restrain an enveloping layer with a large coefficient of thermal expansion and the coefficient of thermal expansion of an insulating layer can be made to approximate with the coefficient of thermal expansion of an electronic device Since the big thermal stress resulting from the difference of the coefficient of thermal expansion of an insulating layer and an electronic device does not occur even if the heat which the electronic device carried generates at the time of actuation, the temperature change of an external environment, etc. are repeatedly impressed to a wiring substrate a crack occurring in both interface or exfoliating among both -- there is nothing -- consequently, wiring -- a conductor and penetration -- poor electrical installation, such as an open circuit, does not occur in a conductor

[0057]

Moreover, since an insulating layer has many amounts of the thermosetting resin with which adhesion with an electronic device is presented by the side to which it touches an electronic device since the thickness of the enveloping layer of the side which touches an electronic device is thicker than the thickness of the enveloping layer of the opposite side Even if the heat which adhesion with an electronic device becomes good and the electronic device carried generates at the time of actuation, the temperature change of an external environment, etc. are repeatedly impressed to a wiring substrate between these -- exfoliation -- generating -- wiring -- a conductor and penetration -- it can consider as the multilayer-interconnection substrate with a built-in electronic device which a conductor was not disconnected and was excellent in electrical installation

dependability.

[Brief Description of the Drawings]

[Drawing 1] It is the sectional view showing an example of the gestalt of operation of the multilayer-interconnection substrate with a built-in electronic device of this invention.

[Drawing 2] It is the sectional view of the capacitor element as an electronic device built in the multilayer-interconnection substrate with a built-in electronic device shown in drawing 1 .

[Drawing 3] It is the sectional view of the insulating layer of the multilayer-interconnection substrate with a built-in electronic device shown in drawing 1 .

[Description of Notations]

1 ..... Liquid crystal polymer layer

2 ..... Enveloping layer

3 ..... Insulating layer

4 ..... wiring -- a conductor

5 ..... penetration -- a conductor

7 ..... Cavernous section

8 ..... Capacitor element as an electronic device

9 ..... Multilayer-interconnection substrate with a built-in electronic device (multilayer-interconnection substrate with a built-in capacitor element)

13 ..... Cash-drawer polar zone

[Translation done.]

2.**** shows the word which can not be translated.

3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the sectional view showing an example of the gestalt of operation of the multilayer-interconnection substrate with a built-in electronic device of this invention.

[Drawing 2] It is the sectional view of the capacitor element as an electronic device built in the multilayer-interconnection substrate with a built-in electronic device shown in drawing 1 .

[Drawing 3] It is the sectional view of the insulating layer of the multilayer-interconnection substrate with a built-in electronic device shown in drawing 1 .

[Description of Notations]

1 ..... Liquid crystal polymer layer

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9 ..... Multilayer-interconnection substrate with a built-in electronic device (multilayer-interconnection substrate with a built-in capacitor element)

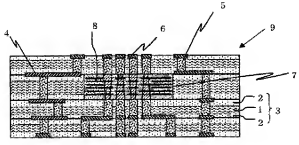
13 ..... Cash-drawer polar zone

[Translation done.]

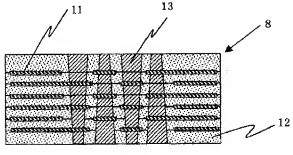
* NOTICES *

DRAWINGS

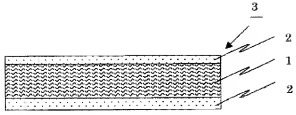
[Drawing 1]



[Drawing 2]



[Drawing 3]



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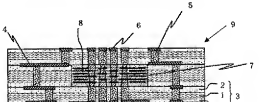
(54)【発明の名称】電子素子内蔵多層配線基板

(57)【要約】
【課題】電子素子と絶縁層間の熱膨張差が大きいために、熱応力によって電気的接続不良が発生する。
【解決手段】有機材料から成る複数の絶縁層３を積層するとともにこれら絶縁層３の表面に配線導体４を形成し、絶縁層３を挟んで上下に位置する配線導体４間を絶縁層３に形成された貫通導体５を介して電気的に接続して成り、絶縁層３の少なくとも一層に設けられた空洞部７の内部に、配線導体４または貫通導体５と電気的に接続される引出し電極部１３を有する電子素子８を内蔵した電子素子内蔵多層配線基板９であって、少なくとも電子素子８の直上および直下に位置する絶縁層３は、液晶ポリマー層１の上下面に熱硬化性樹脂により無機絶縁粉末を結合して成る被覆層２を形成したものであり、電子素子８に接する側の被覆層２の厚みが、その反対側の被覆層２の厚みよりも厚い。
【選択図】　図１



【特許請求の範囲】
【請求項1】
有機材料から成る複数の絶縁層を積層するとともにこれら絶縁層の表面に配線導体を形成し、前記絶縁層を挟んで上下に位置する前記配線導体間を前記絶縁層に形成された貫通導体を介して電気的に接続して成り、前記絶縁層の少なくとも一層に設けられた空洞部の内部に、前記配線導体または前記貫通導体と電気的に接続される引出し電極部を有する電子素子を内蔵した電子素子内蔵多層配線基板であって、少なくとも前記電子素子の直上および直下に位置する前記絶縁層は、液晶ポリマー層の上下面に熱硬化性樹脂により無機絶縁粉末を結合して成る被覆層を形成したものであり、前記電子素子に接する側の前記被覆層の厚みが、その反対側の前記被覆層の厚みよりも厚いことを特徴とする電子素子内蔵多層配線基板。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】
本発明は、各種ＡＶ機器や家電機器・通信機器・コンピュータやその周辺機器等の電子機器に使用されるコンデンサ素子等の電子素子を内蔵した配線基板に関する。
【０００２】
【従来の技術】
従来、配線基板は、アルミナ等のセラミック材料から成る絶縁層あるいはガラスエポキシ樹脂等の有機樹脂材料から成る絶縁層の内部および表面に複数の配線導体を形成し、上下に位置する配線導体間を絶縁層に形成した貫通導体を介して電気的に接続して成り、この配線基板の表面に半導体素子やコンデンサ・抵抗素子等の電子素子を搭載するとともにこれらの電極を各配線導体に接続することによって電子機器に使用される電子装置が形成されている。
【０００３】
しかしながら、近年、電子機器は、移動体通信機器に代表されるように小型・薄型・軽量化が要求されてきており、このような電子機器に搭載される配線基板も小型・高密度化が要求されるようになってきている。
【０００４】
このような要求に対応するために、特開平１１－２２０２６２号公報には、配線基板の表面に搭載される電子素子の数を減らして配線基板を小型化する目的で、配線基板の内部にチップ状コンデンサ素子等の回路部品を内蔵した回路部品内蔵モジュールが提案されている。
【０００５】
【特許文献１】
特開平１１－２２０２６２号公報
【０００６】
【発明が解決しようとする課題】
しかしながら、特開平１１－２２０２６２号公報に示された回路部品内蔵モジュールは、銅箔上に実装した回路部品をエポキシ樹脂やシアネート樹脂から成る絶縁性基板に埋設することにより製作されており、エポキシ樹脂やシアネート樹脂は熱膨張係数が大きいため、電子素子が作動時に発生する熱や外部環境の温度変化等が繰り返し印加されると、回路部品を内蔵する絶縁性基板の膨張あるいは収縮により回路部品と配線パターンの実装部に応力が集中してクラックが発生し、断線等の電気的接続不良が発生してしまうという問題点を有していた。
【０００７】
本発明は、かかる従来技術の問題点に鑑み案出されたものであり、その目的は、接続信頼性に優れた小型で軽量な電子素子内蔵多層配線基板を提供することにある。
【０００８】
【課題を解決するための手段】

本発明の電子素子内蔵多層配線基板は、有機材料から成る複数の絶縁層を積層するとともにこれら絶縁層の表面に配線導体を形成し、前記絶縁層を挟んで上下に位置する前記配線導体間を前記絶縁層に形成された貫通導体を介して電気的に接続して成り、前記絶縁層の少なくとも一層に設けられた空洞部の内部に、前記配線導体または前記貫通導体と電気的に接続される引出し電極部を有する電子素子を内蔵した電子素子内蔵多層配線基板であって、少なくとも前記電子素子の直上および直下に位置する前記絶縁層は、液晶ポリマー層の上下面に熱硬化性樹脂により無機絶縁粉末を結合して成る被覆層を形成したものであり、前記電子素子に接する側の前記被覆層の厚みが、その反対側の前記被覆層の厚みよりも厚いことを特徴とするものである。

【０００９】

本発明の電子素子内蔵多層配線基板によれば、少なくとも電子素子の直上および直下に位置する絶縁層は、液晶ポリマー層の上下面に熱硬化性樹脂により無機絶縁粉末を結合して成る被覆層を形成して成るものであることから、熱膨張係数の小さい液晶ポリマー層が熱膨張係数の大きい被覆層を拘束して絶縁層の熱膨張係数を電子素子の熱膨張係数と近似させることができるので、搭載される電子素子が作動時に発生する熱や外部環境の温度変化等が配線基板に繰り返し印加されたとしても、絶縁層と電子素子との接合面に両者の熱膨張係数の相異に起因する大きな熱応力が発生することはないので、両者の接合面にクラックが発生したり両者間で剥離することはなく、その結果、配線導体や貫通導体に断線等の電気的接続不良が発生することがなく、接続信頼性に優れた電子素子内蔵多層配線基板とすることができる。

【００１０】

また、絶縁層は、電子素子に接する側の被覆層の厚みが、その反対側の被覆層の厚みよりも厚いことから、電子素子に接する側で電子素子との接着に供する熱硬化性樹脂の量が多いので電子素子との接着が良好となり、搭載される電子素子が作動時に発生する熱や外部環境の温度変化等が配線基板に繰り返し印加されたとしても、これらの間で剥離が発生して配線導体や貫通導体が断線することはなく、電気的接続信頼性に優れた電子素子内蔵多層配線基板とすることができる。

【００１１】

【発明の実施の形態】

次に本発明の電子素子内蔵多層配線基板を添付の図面に基づいて詳細に説明する。

【００１２】

図１は、本発明の、電子素子内蔵多層配線基板の実施の形態の一例を示す断面図であり、図２は図１に示す電子素子内蔵多層配線基板に内蔵された電子素子の拡大断面図である。また、図３は図１に示す絶縁層３の部分拡大断面図である。

【００１３】

これらの図において、１は液晶ポリマー層、２は被覆層であり、主にこれらで絶縁層３が形成されており、また、４は配線導体、５は貫通導体、８は電子素子としてのコンデンサ素子であり、主に絶縁層３と、配線導体４と、貫通導体５と、コンデンサ素子８とで本実施例の電子素子内蔵多層配線基板９が構成されている。

【００１４】

なお、本実施例では、絶縁層３を４層積層して成るとともに、１個のコンデンサ素子８を埋設して成るコンデンサ素子内蔵多層配線基板について説明する。

【００１５】

まず、電子素子内蔵多層配線基板９に内蔵される電子素子としてのコンデンサ素子８について説明する。

【００１６】

コンデンサ素子８は、縦・横・高さがそれぞれ１～５ｍｍの直方体であり、図２に断面図で示すように、電極層１１とセラミック誘電体層１２とを交互に複数層積層するとともに所定の電極層１１同士を電気的に接続する引出し電極部１３を上下に貫通するように設けることにより形成されている。

【００１７】
このようなセラミック誘電体層１２の材料としては、種々の誘電体セラミック材料を用いることができ、例えば、$BaTiO_3$やLaTiO$_3$・CaTiO$_3$・SrTiO$_3$等のセラミック組成物、あるいは、$BaTiO_3$の構成元素であるBaをCaで、TiをZrやSnで部分的に置換した固溶体等のチタン酸バリウム系材料や、鉛系ペロブスカイト型構造化合物等が挙げられる。
【００１８】
また、電極層１１を形成する材料としては、例えばPdやAg・Pt・Ni・Cu・Pb等の金属やそれらの合金が用いられる。
【００１９】
さらに、コンデンサ素子８は、多数の電極層１１に電気的に接続した複数の引出し電極部１３を電極層１１とセラミック誘電体層１２の積層体を貫通するように有しており、これらはコンデンサ素子８の電極層１１と電子素子内蔵多層配線基板９の配線導体４や貫通導体５とを電気的に接続する作用を成す。なお、本例では引出し電極部１３を電極層１１とセラミック誘電体層１２との積層体を貫通するように設けたが、引出し電極部１３は電極層１１とセラミック誘電体層１２との積層体の端面に半田ペーストを印刷することによって設けてもよい。ただし、微細化・工程の容易性・インダクタンス低減という観点からは、引出し電極部１３は電極層１１とセラミック誘電体層１２との積層体を貫通するように形成されることが好ましい。
【００２０】
また、引出し電極部１３を形成する導体としては、PdやAg・Pt・Ni・Cu・Pb等の金属やそれらの合金が用いられ、特に電極層１１との電気的接続を良好にするという観点からは、電極層１１と同じ材質のものを含有することが好ましい。なお、引出し電極部１３の径は数１０μm～数mmであり、コンデンサ素子８の大きさにあわせて適宜決めればよい。
【００２１】
このようなコンデンサ素子８は、まず、例えば周知のシート成形法により製作したセラミック誘電体層１２用の複数の$BaTiO_3$誘電体セラミックグリーンシートの表面に周知のペースト作成法により作成した電極層１１用の金属ペーストをスクリーン印刷法により所定形状となるように印刷し、続いてこれらのセラミックグリーンシートを所定順序に積層するとともに圧着して積層体を得、次に、この積層体にパンチング加工やUV－YAGレーザやエキシマレーザ・炭酸ガスレーザ等によるレーザ加工により引出し電極部１３形成用の貫通孔を穿孔するとともにその貫通孔内に引出し電極部１３用の金属ペーストを充填し、最後にその積層体を所定の大きさに切断するとともに８００～１６００℃の温度で焼成することにより製作される。
【００２２】
なお、特に微細な貫通孔とするためには、レーザによる穿設加工により貫通孔を形成することが好ましい。また、貫通孔は、内部に充填される導体と電極層１１との電気的接続を良好にするために、打ち抜き加工やレーザ穿設加工後に超音波洗浄処理やデスミア処理等を施すことが好ましい。
【００２３】
また、引出し電極部１３用の金属ペーストは、有機溶剤に有機バインダ樹脂を溶解させた有機ビヒクル中に金属粉末を分散させることにより形成される。なお、ビヒクル中には、これらの他、各種分散剤・活性剤・可塑剤などが必要に応じて添加されていても良い。この導電ペーストに用いられる有機バインダ樹脂は、金属粉末を均質に分散させるとともに貫通孔への埋め込みに適正な粘度とレオロジーを与える役割をもっており、例えば、アクリル樹脂やフェノール樹脂・アルキッド樹脂・ロジンエステル・エチルセルロース・メチルセルロース・ポリビニルアルコール・ポリビニルブチラート等が挙げられる。特に、金属粉末の分散性を良くするという観点からは、アクリル樹脂を用いることが好ましい。
【００２４】

さらに、この導電ペーストに用いられる有機溶剤は、有機バインダ樹脂を溶解して金属粉末粒子を分散させ、このような混合系全体をペースト状にする役割をなし、例えば、α－テルピネオールやベンジルアルコール等のアルコール系や炭化水素系・エーテル系・ブチルカルビトールアセテート等のエステル系・ナフサ等が用いられ、特に、金属粉末の分散性を良くするという観点からは、α－テルピネオール等のアルコール系溶剤を用いることが好ましい。

【００２５】

さらにまた、この導電ペーストは、埋め込み・焼成後のコンデンサ磁器への接着強度を上げるために、ガラスフリットやセラミックフリットを加えたペーストとすることができる。この場合のガラスフリットやセラミックフリットとしては特に限定されるものではなく、例えば、ホウ珪酸系やホウ珪酸亜鉛系のガラスやチタニア・チタン酸バリウムなどのチタン系酸化物などを適宜用いることができる。

【００２６】

なお、コンデンサ素子８の表面は、絶縁層３との接着性を向上させるという観点からは、セラミック誘電体層１２の表面の算術平均粗さＲの最大値ＲｍａｘをＯ．２μｍより大きく、望ましくは０．５μｍ以上、最適には１．０μｍ以上とすることが好ましい。なお、セラミック誘電体層１２の表面粗さＲの最大値Ｒｍａｘが５μｍを超えると、コンデンサ素子８に割れや欠けが発生し易くなる傾向があるため、表面粗さＲの最大値ＲｍａｘをＳμｍ以下としておくことが好ましい。

【００２７】

このようなコンデンサ素子８表面のセラミック誘電体層１２の表面は、焼成前のグリーンシート積層体の段階で、積層体の表面をブラシ研磨による粗化処理やあらかじめ凹凸加工した平板を押し付けるなどの方法で物理的に凹凸をつけた後、あるいはレーザによりグリーンシート積層体表面に非貫通孔を開けることによりディンプル加工を施した後、焼成することにより所望の表面粗さとすることができる。また、セラミック誘電体層１２に用いられるセラミック材料よりも焼成時の耐熱性が高く平均粒子径が１０μｍ以上のセラミック粉末、あるいはセラミック誘電体層１２に用いられるセラミック材料の一部と反応性を有し、平均径が１０μｍ以上のセラミック粉末を一部が埋入するようにグリーンシート積層体表面に付着させて焼成することによって所望の表面粗さとしても良い。さらに、グリーンシート積層体の焼成後のコンデンサ素子８の表面をサンドブラスト等の物理的手法あるいはエッチング等の化学的手法により粗化しても良い。

【００２８】

次に、本発明の電子素子内蔵多層配線基板９を図１および図３に基づいて詳細に説明する。

【００２９】

本発明の電子素子内蔵多層配線基板９は、図１に断面図で示すように、複数の絶縁層３を積層するとともにこれら絶縁層３の表面に銅箔から成る配線導体４が形成されている。また、絶縁層３を挟んで上下に位置する配線導体４間を絶縁層３に形成された導電性樹脂から成る貫通導体５を介して電気的に接続して成り、上下の最外層に位置する配線導体４の一部が外部電気回路と接続される接続パッド６とされている。さらに、絶縁層３の少なくとも一層に設けられた空洞部７の内部に前述のコンデンサ素子８を内蔵するとともに、そのコンデンサ素子８の上下両主面において引出し電極部１０が貫通導体５を介して配線導体４やその一部から成る接続パッド６に電気的に接続されている。

【００３０】

そして、本発明の電子素子内蔵多層配線基板９においては、少なくともコンデンサ素子８の直上および直下に位置する絶縁層３は、図３に断面図で示すように、液晶ポリマー層１の上下面に熱硬化性樹脂により無機絶縁粉末を結合して成る被覆層２を形成した構成となっている。なお、本実施例においては、４層の絶縁層３全てが液晶ポリマー層１の上下面に熱硬化性樹脂により無機絶縁粉末を結合して成る被覆層２を形成した構成とした場合の例を示す。

【００３１】
なお、ここで液晶ポリマーとは、溶融時に液晶状態あるいは光学的に複屈折する性質を有するポリマーを指し、一般に溶液状態で液晶性を示すリオトロピック液晶ポリマーや溶融時に液晶性を示すサーモトロピック液晶ポリマー、あるいは、熱変形温度で分類される１型・２型・３型すべての液晶ポリマーを含むものであり、本発明に用いる液晶ポリマーとしては、温度サイクル信頼性・半田耐熱性・加工性の観点からは２００～４００℃の温度、特に２５０～３５０℃の温度に融点を有するものが好ましい。また、ポリフェニレンエーテル系有機物とは、ポリフェニレンエーテル樹脂やポリフェニレンエーテルに種々の官能基が結合した樹脂、あるいはこれらの誘導体・重合体を意味するものである。
【００３２】
このような液晶ポリマー層１は、絶縁層３に機械的な強度を付与するとともに絶縁層３の熱膨張係数をコンデンサ素子８の熱膨張係数に近似させる機能を有し、層としての物性を損なわない範囲内で、熱安定性を改善するための酸化防止剤や耐光性を改善するための紫外線吸収剤等の光安定剤、難燃性を付加するためのハロゲン系もしくはリン酸系の難燃性剤、アンチモン系化合物やホウ酸亜鉛・メタホウ酸バリウム・酸化ジルコニウム等の難燃助剤、潤滑性を改善するための高級脂肪酸や高級脂肪酸エステル・高級脂肪酸金属塩・フルオロカーボン系界面活性剤等の滑剤、熱膨張係数を調整するため、および／または機械的強度を向上するための酸化アルミニウム・酸化珪素・酸化チタン・酸化バリウム・酸化ストロンチウム・酸化ジルコニウム・酸化カルシウム・ゼオライト・窒化珪素・窒化アルミニウム・炭化珪素・チタン酸カリウム・チタン酸バリウム・チタン酸ストロンチウム・チタン酸カルシウム・ホウ酸アルミニウム・スズ酸バリウム・ジルコン酸バリウム・ジルコン酸ストロンチウム等の充填材を含有してもよい。
【００３３】
なお、上記の充填材等の粒子形状は、球状・針状・フレーク状等があり、充填性の観点からは球状が好ましい。また、粒子径は、通常０．１～１５μｍ程度であり、液晶ポリマー層１の厚みよりも小さい。
【００３４】
また、被覆層２は、後述する配線導体４を被着形成する際の接着剤の機能を有するとともに、コンデンサ素子８を空洞部７に内蔵した際にコンデンサ素子８を空洞部７内部に固定させる接着剤としての役割や絶縁層３同士を積層する際の接着剤の役目を果たす。
【００３５】
被覆層２は、例えばポリフェニレンエーテル樹脂やその誘導体、または、これらのポリマーアロイ等のポリフェニレンエーテル系有機物を３０～９０体積％含有しており、とりわけ熱サイクル信頼性や配線導体４を接着する際の位置精度の観点からは、アリル変性ポリフェニレンエーテル等の熱硬化性ポリフェニレンエーテルを含有することが好ましい。
【００３６】
なお、ポリフェニレンエーテル系有機物等の熱硬化性樹脂の含有量が３０体積％未満であると、後述する無機絶縁粉末との混練性が低下する傾向があり、また、９０体積％を超えると、液晶ポリマー層１表面に被覆層２を形成する際に、被覆層２の厚みバラツキが大きくなる傾向がある。従って、ポリフェニレンエーテル系有機物等の熱硬化性樹脂の含有量は、３０～９０体積％の範囲が好ましい。
【００３７】
また、被覆層２は、液晶ポリマー層１との密着性や配線導体４・後述する貫通導体５との密着性を良好にするという観点からは、重合反応可能な官能基を２個以上有する多官能性モノマーあるいは多官能性重合体等の添加剤を含有することが好ましく、例えば、トリアリルイソシアヌレートやトリアリルシアヌレートおよびこれらの重合体等を含有することが好ましい。
【００３８】
さらに、被覆層２は、その熱膨張係数を調整したり機械的強度を向上したりするための酸化アルミニウムや酸化珪素・酸化チタン・酸化バリウム・酸化ストロンチウム・酸化ジル

コニウム・酸化カルシウム・ゼオライト・窒化珪素・窒化アルミニウム・炭化珪素・チタン酸カリウム・チタン酸バリウム・チタン酸ストロンチウム・チタン酸カルシウム・ホウ酸アルミニウム・スズ酸バリウム・ジルコン酸バリウム・ジルコン酸ストロンチウム等の粒径が０．１～２μｍの無機絶縁粉末が１０～７０体積％を含有している。

【００３９】

なお、このような無機絶縁粉末は、その粒径が０．１μｍ未満では、この無機粉末をペースト化する際の混練工程において、無機粉末同士で凝集粒となってしまい、その凝集粒部分が被覆層２となった後の絶縁信頼性を低下させる傾向にあり、２μｍを超えると、被覆層２表面の平坦性が低下し、被着させる配線導体４との接着性が低下し、結果として、配線導体４の位置ずれが大きくなる傾向にある。従って、被覆層２に含有された無機絶縁粉末の粒径は、０．１～２μｍの範囲が好ましい。また、特に絶縁層３を積層・加圧して電子素子内蔵多層配線基板９を形成する際に、被覆層２の流動性を抑制し、貫通導体５の位置ずれや被覆層２の厚みばらつきを防止するという観点からは、被覆層２は１０体積％以上の無機絶縁粉末を含有することが好ましい。さらに、液晶ポリマー層１との接着界面および配線導体４との接着界面での半田リフロー時の剥離を防止するという観点からは、無機絶縁粉末の含有量を７０体積％以下とすることが好ましい。

【００４０】

なお、無機絶縁粉末の形状は、球状・針状・フレーク状等があり、充填性の観点からは、球状が好ましい。また、被覆層２は、弾性率を調整するためのゴム成分や熱安定性を改善するための酸化防止剤、耐光性を改善するための紫外線吸収剤等の光安定剤、難燃性を付加するためのハロゲン系もしくはリン酸系の難燃性剤、アンチモン系化合物やホウ酸亜鉛・メタホウ酸バリウム・酸化ジルコニウム等の難燃助剤、潤滑性を改善するための高級脂肪酸や高級脂肪酸エステルや高級脂肪酸金属塩・フルオロカーボン系界面活性剤等の滑剤、あるいは、無機絶縁粉末との親和性を高めこれらの接合性向上と機械的強度を高めるためのシラン系カップリング剤やチタネート系カップリング剤等のカップリング剤を含有してもよい。

【００４１】

このような絶縁層３は、例えば粒径が０．１～２μｍの酸化珪素等の無機絶縁粉末に、熱硬化性ポリフェニレンエーテル樹脂と溶剤・可塑剤・分散剤等を添加して得た被覆層２用のペーストを、プラズマ処理によりトリアリルイソシアヌレートとの接触角が３～５０°であって、かつ表面エネルギーが４５～７０ｍＪ／ｍ^{2}となるように表面処理した液晶ポリマー層１の上下表面に従来周知のドクターブレード法等のシート成型法を採用して塗布した後、あるいは上記のペースト中に液晶ポリマー層１を浸漬し垂直に引き上げることによって液晶ポリマー層１の表面に上記のペースト層を塗布した後、これを熱硬化性樹脂が完全硬化しない温度に加熱して温風乾燥することにより絶縁層３となる前駆体シートを製作し、それらに適当な打ち抜き加工を施すと共に複数枚を上下に積層し、それを熱硬化させることにより形成される。

【００４２】

なお、ペーストは、好適には、熱硬化性ポリフェニレンエーテル樹脂と無機絶縁粉末の複合材料に、トルエン・酢酸ブチル・メチルエチルケトン・メタノール・メチルセロソルブアセテート・イソプロピルアルコール・メチルイソブチルケトン・ジメチルホルムアミド等の溶媒を添加してなる所定の粘度を有する流動体であり、その粘度は、シート成形法にもよるが１００～３０００ポイズの範囲が好ましい。

【００４３】

また、絶縁層３の表面に形成された配線導体４は、銅・金・銀・アルミニウム等から選ばれる１種または２種以上の合金から成り、絶縁層３を挟んで上下に位置する配線導体４同士が貫通導体５を介して電気的に接続されることにより立体的な高密度配線が可能となっている。

【００４４】

なお、本例では、配線導体４の形成を転写法によって行なっており、このような配線導体

４は、次に述べる方法により形成される。まず、離型シートの表面にめっき法などによって製作され、銅・金・銀・アルミニウム等から選ばれる１種または２種以上の合金からなる厚さ１～３５μｍの電解金属箔を接着し、その表面に所望の配線パターンの鏡像パターンとなるようにレジスト層を形成した後、エッチング・レジスト除去によって離型シート上に所定の配線パターンの鏡像の配線導体４が形成された転写シートを準備する。次に、表面に配線導体４が形成された転写シートを絶縁層３用の前駆体シートの表面および／または裏面へ重ね合わせ、しかる後、圧力が０．５～１０ＭＰａ、温度が６０～１５０℃の条件で加圧加熱した後、離型シートを剥がすことにより、配線導体４を前駆体シート上に転写する。そして、前駆体シートを複数枚積層後に熱硬化させる際の加熱・加圧により絶縁層３の表面に披着される。なお、上下の最外層に位置する配線導体４の一部は外部電気回路と接続される接続パッド６とされている。

【００４５】

また、貫通導体５は、絶縁層３を挟んで上下に位置する配線導体４同士および配線導体４とコンデンサ素子８の引出し電極部１３とを電気的に接続するための接続導体として機能し、絶縁層３用の前駆体シートに貫通導体５形成用の貫通孔をレーザ加工により穿孔するとともに、その貫通孔内に銅・銀・金・半田等の金属粉末とエポキシ樹脂やビスマレイミドトリアジン樹脂・熱硬化性ポリフェニレンエーテル樹脂・液晶ポリマー樹脂等の有機樹脂材料とにトルエン・酢酸ブチル・メチルエチルケトン・メタノール・メチルセロソルブアセテート・イソプロピルアルコール・メチルイソブチルケトン・ジメチルホルムアミド等の溶媒を添加混合して成る貫通導体５用の導電性ペーストを従来周知のスクリーン印刷法等を採用して充填し、それを前駆体シートとともに熱硬化させることにより形成される。

【００４６】

さらに、絶縁層３の一部には空洞部７が形成されており、この空洞部７の内部には前述したコンデンサ素子８がその引出し電極部１３と配線導体４とが空洞部７の直上および直下の絶縁層３に設けた貫通導体５を介して電気的に接続されるようにして収納されている。

【００４７】

このような空洞部７は、絶縁層３用の前駆体シートの一部に、例えばレーザ加工により貫通穴を形成しておくことにより形成される。そして、そのような貫通穴内にコンデンサ素子８を挿入するとともに、コンデンサ素子８の引出し電極部１３に対応する位置に貫通導体５用の導電性ペーストが充填された他の絶縁層３用の前駆体シートをその上下に積層し、温度が１５０～３００℃、圧力が０．５～１０ＭＰａの条件で３０分～２４時間ホットプレスして前駆体シートおよび導電性ペーストを熱硬化させることによりコンデンサ素子８が空洞部７内に収納されるとともにコンデンサ素子８の引出し電極部１３とその上下の絶縁層３に設けた貫通導体５とが電気的に接続される。

【００４８】

なお、空洞部７の縦・横の長さは、コンデンサ素子８の縦または横の長さをＬμｍとした場合、Ｌ＋３～Ｌ＋３０μｍであり、貫通導体５とコンデンサ素子８との接続における位置精度の観点からはＬ＋３０μｍ以下が好ましく、コンデンサ素子８を空洞部７に挿入する際にコンデンサ素子８を挿入し易くするという観点からはＬ＋３μｍ以上が好ましい。

【００４９】

さらに、空洞部７が形成されている絶縁層３において、被覆層２の厚みの合計が液晶ポリマー層１の厚み以下であると、空洞部７に収納するコンデンサ素子８と絶縁層３との接着剤の効果を有する被覆層２の接着面積が小さくなりコンデンサ素子８を固定する接着力が小さくなってしまい、温度サイクル試験でコンデンサ素子８と配線導体４との接続部に負荷が加わった際に、断線しやすくなる傾向がある。従って、空洞部７が形成されている絶縁層３における被覆層２の厚みの合計は液晶ポリマー層１の厚みよりも大きいことが好ましい。なお、絶縁層３を積層する際の樹脂流れによる位置合わせ精度の低下を防止するという観点からは、被覆層２の厚みの合計は液晶ポリマー層１の厚みの１．４倍以下であることが好ましい。

【００５０】
そして、本発明の電子素子内蔵多層配線基板９においては、コンデンサ素子８が収納された空洞部７の上下に位置する絶縁層３は、液晶ポリマー層１の上下面に熱硬化性樹脂により無機絶縁粉末を結合して成る被覆層２を形成して成るとともに、コンデンサ素子８に接する側の被覆層２の厚みがその反対側の被覆層２の厚みよりも厚く形成されており、そのことが重要である。
【００５１】
本発明の電子素子内蔵多層配線基板９によれば、少なくともコンデンサ素子８の直上および直下に位置する絶縁層３を、液晶ポリマー層１の上下面に熱硬化性樹脂により無機絶縁粉末を結合して成る被覆層２を形成して成るものとしたことから、熱膨張係数の小さい液晶ポリマー層１が熱膨張係数の大きい被覆層２を拘束して絶縁層３の熱膨張係数をコンデンサ素子８の熱膨張係数と近似させることができるので、搭載される電子素子が作動時に発生する熱や外部環境の温度変化等が配線基板に繰り返し印加されたとしても、絶縁層３とコンデンサ素子８の熱膨張係数の相異に起因する大きな熱応力が発生することはないので、両者の界面にクラックが発生したり両者間で剥離することはない。
【００５２】
また、コンデンサ素子８の上下に位置する絶縁層３においてコンデンサ素子８に接する側の被覆層２の厚みがその反対側の被覆層２の厚みよりも厚くなっており、コンデンサ素子８に接する側でコンデンサ素子８との接着に供する熱硬化性樹脂の量が多いので、コンデンサ素子８との接着性が良好となり、搭載される電子素子が作動時に発生する熱や外部環境の温度変化等が配線基板に繰り返し印加されたとしても、これらの間で剥離して配線導体４や貫通導体５が断線することはなく、電気的接続信頼性に優れた電子素子内蔵多層配線基板９とすることができる。
【００５３】
なお、コンデンサ素子８の直上および直下に位置する絶縁層３において、コンデンサ素子８に接する側の被覆層２の厚みがその反対側の被覆層２の厚みの１．２倍未満であると、コンデンサ素子８と絶縁層３との接着力が低下する危険性が大きくなり、他方、３倍を超えると、本発明の電子素子内蔵多層配線基板９を作る際の加熱工程において、液晶ポリマー層１の上下で被覆層２の収縮差が大きくなり、その収縮差による応力により本発明の電子素子内蔵多層配線基板９が破壊され易くなる。したがって、コンデンサ素子８の直上および直下に位置する絶縁層３において、コンデンサ素子８に接する側の被覆層２の厚みはその反対側の被覆層２の厚みの１．２～３倍の範囲が好ましい。
【００５４】
かくして、本発明の電子素子内蔵多層配線基板９によれば、上記構成の電子素子内蔵多層配線基板９の最外層に位置する配線導体４の一部から成る接続パッド６に半田等の導体バンプ（図示せず）を介して半導体素子等の電子部品（図示せず）を電気的に接続することにより、内蔵する電子素子８と貫通導体５や配線導体４との接続信頼性に優れた混成集積回路とすることができる。
【００５５】
なお、本発明の電子素子内蔵多層配線基板９は上述の実施例に限定されるものではなく、本発明の要旨を逸脱しない範囲であれば種々の変更は可能であり、例えば、上述の実施例では４層の絶縁層３を積層することによって電子素子内蔵多層配線基板９を製作したが、３層や５層以上の絶縁層３を積層して電子内蔵多層配線基板９を製作してもよい。また、電子素子８を埋設するための空洞部７となる貫通穴が形成された絶縁層３を１層としたが、２層以上としてもよい。さらに本実施例では、電子素子がコンデンサ素子８の場合について説明したが、電子素子が抵抗器やコイル等の他の電子素子であってもよい。
【００５６】
【発明の効果】
本発明の電子素子内蔵多層配線基板によれば、少なくとも電子素子の直上および直下に位置する絶縁層は、液晶ポリマー層の上下面に熱硬化性樹脂と無機絶縁粉末とを含有する被

覆層を有していることから、熱膨張係数の小さい液晶ポリマー層が熱膨張係数の大きい被覆層を拘束して絶縁層の熱膨張係数を電子素子の熱膨張係数と近似させることができるので、搭載される電子素子が作動時に発生する熱や外部環境の温度変化等が配線基板に繰り返し印加されたとしても、絶縁層と電子素子の熱膨張係数の相異に起因する大きな熱応力が発生することはないので、両者の界面にクラックが発生したり両者間で剥離することはなく、その結果、配線導体や貫通導体に断線等の電気的接続不良が発生することはない。

【００５７】

また、絶縁層は、電子素子に接する側の被覆層の厚みが、その反対側の被覆層の厚みよりも厚いことから、電子素子に接する側で電子素子との接着に供する熱硬化性樹脂の量が多いので、電子素子との接着が良好となり、搭載される電子素子が作動時に発生する熱や外部環境の温度変化等が配線基板に繰り返し印加されたとしても、これらの間で剥離が発生して配線導体や貫通導体が断線することはなく、電気的接続信頼性に優れた電子素子内蔵多層配線基板とすることができる。

【図面の簡単な説明】

【図１】本発明の電子素子内蔵多層配線基板の実施の形態の一例を示す断面図である。

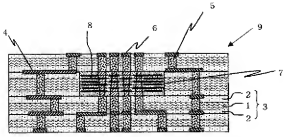
【図２】図１に示す電子素子内蔵多層配線基板に内蔵された電子素子としてのコンデンサ素子の断面図である。

【図３】図１に示す電子素子内蔵多層配線基板の絶縁層の断面図である。

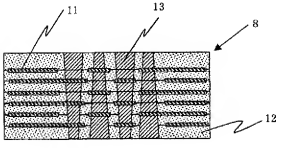
【符号の説明】

１・・・・・・・・・液晶ポリマー層
２・・・・・・・・・被覆層
３・・・・・・・・・絶縁層
４・・・・・・・・・配線導体
５・・・・・・・・・貫通導体
７・・・・・・・・・空洞部
８・・・・・・・・・電子素子としてのコンデンサ素子
９・・・・・・・・・電子素子内蔵多層配線基板（コンデンサ素子内蔵多層配線基板）
１３・・・・・・・・・引出し電極部

【図1】



【図2】



【図3】